AP233 Systems Engineering

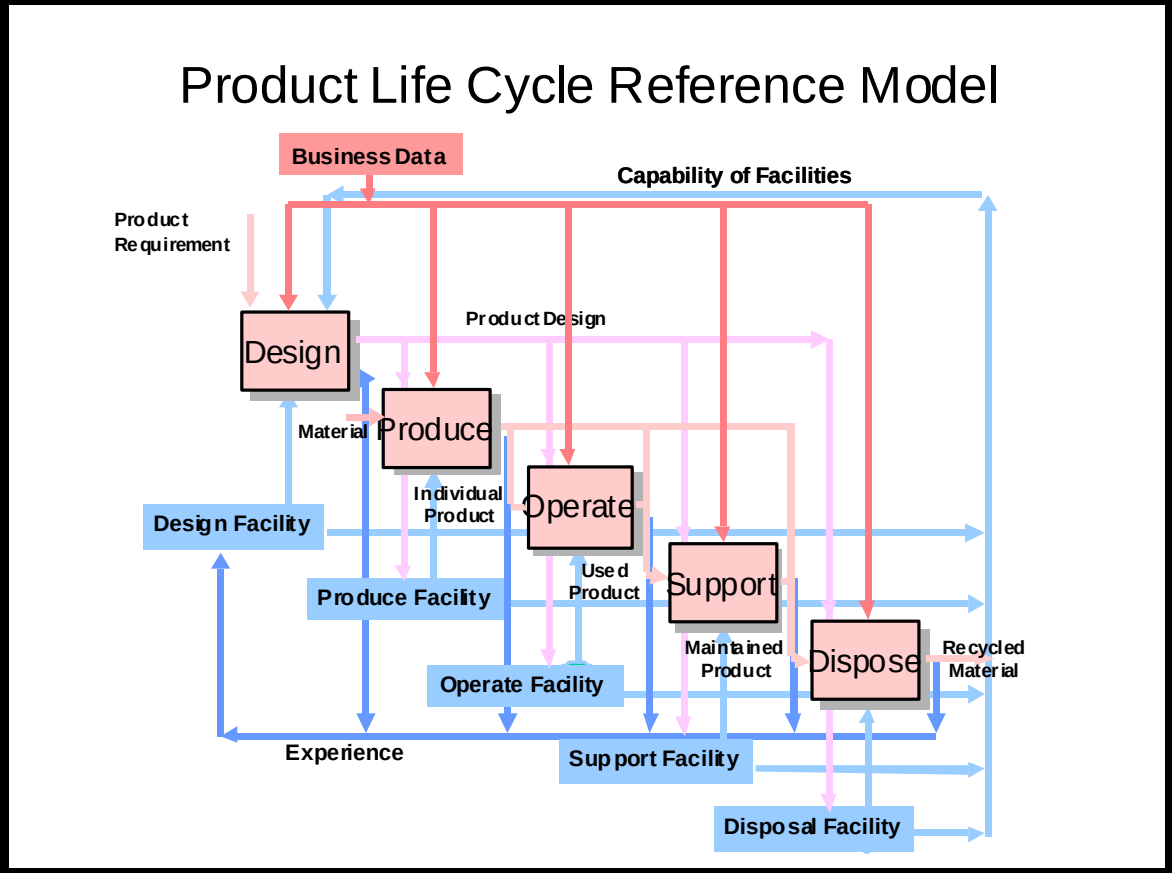
A NASA/PDES Inc. Needs Perspective

as seen by

Harold P. Frisch

PDES, Inc.®

STEP/SC4 Framework
NASA Product Life Cycle View

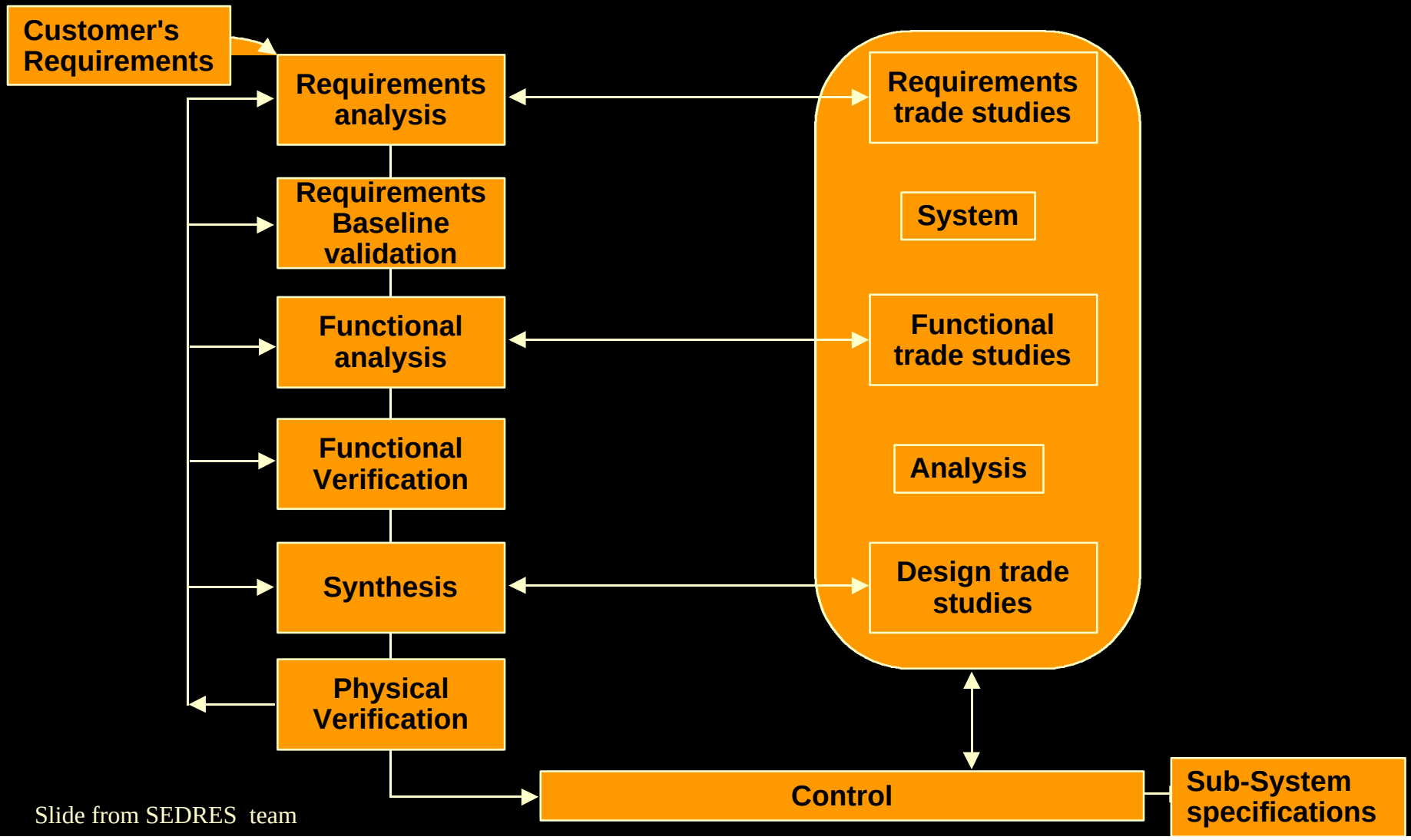


Slide from STEP Frameworks document

H.P. Frisch
21-Jan-00

PDES, Inc.®

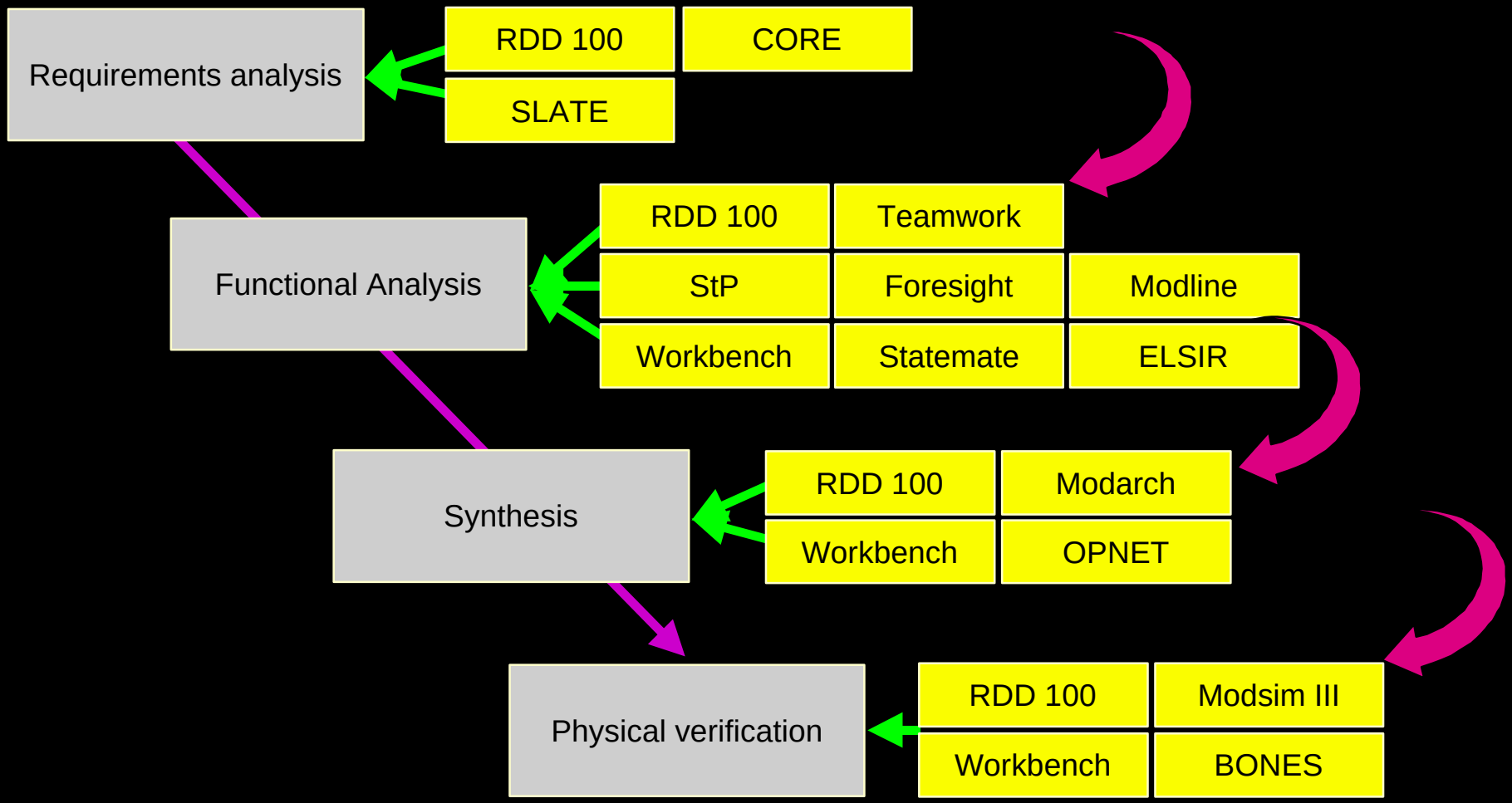
SYSTEM ENGINEERING PROCESS - IEEE 1220



Slide from SEDRES team

PDES, Inc.®

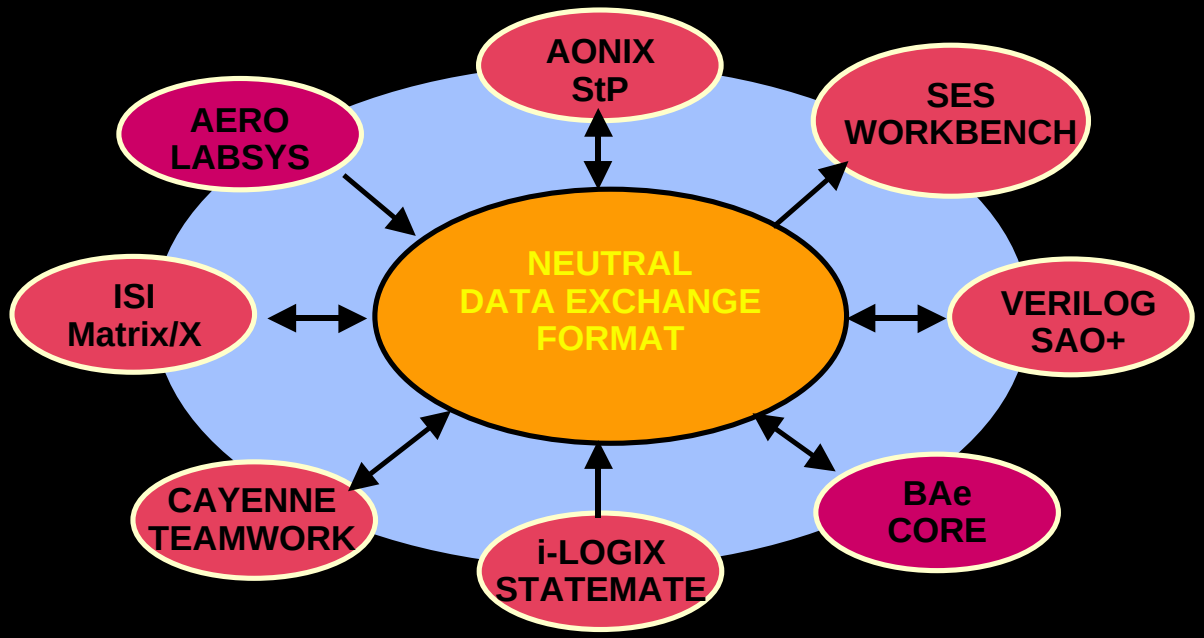
SE PROCESS w.r.t some SE TOOLS



Slide from SEDRES team

PDES, Inc.®

AP233
Neutral Data Format



Slide from SEDRES team

PDES, Inc.®

AP233 NASA/PDES Needs

- For products within an established product-line
  - Unmanned spacecraft, space based science instruments
- Modeling needs - Do you agree ?
  - System engineering models bring minimal added value
    - Finite state machine, causal chain
  - Engineering test & analysis models for domain and cross domain what-if, trade, and anomaly studies of critical importance
- Need SE Interface to/from Engineering support domains
  - Record of: Who, what, how, when, assumptions, limitations
  - Sufficient information to support reuse/redo decisions

SE - System Engineering
EA - Engineering Analysis

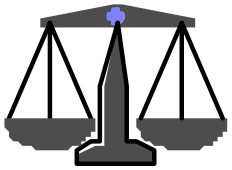
PDES, Inc.®

AP233 NASA/PDES Needs

- At SE interface to the engineering support domains enable the representation and exchange of:
  - System Characterization Properties
  - Behavior Models (static, quasi-static, dynamic)
  - Metadata (who, what, when, how, why, …)
- Technical Data Packages exchanged at interface
  - From SE to Engineering Support Domains and back
  - Package has all metadata to enable future user to determine if information is reusable for new need
  - Provide for archival/retrieval of Technical Data Packages

Product, Properties, Representation and Presentation

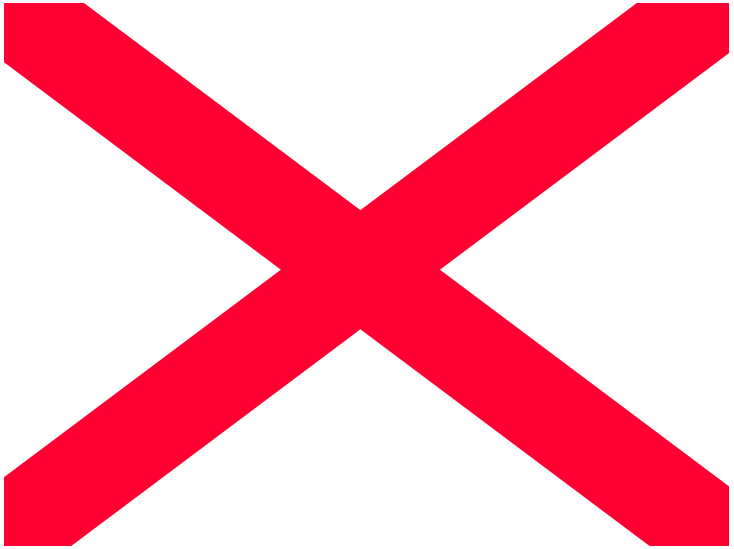
Product Data	Properties	Representation Data	Presentation Data
Identifies the product	Defines attributes of the product	Represents a property of the product	Defines how to present the data



Examples

	Shape	Wireframes Surfaces Solids	Views Layers Colours Groups
Product	Behaviour	Analytical Model	
	Fracture toughness	Numeric value with uncertainty	Decimal number

PDES, Inc



Slide from STEP Frameworks document

H.P. Frisch
21-Jan-00

PDES, Inc.®

On Property Metadata

- Property -
  - an observable or measurable aspect of a
    - product, state or activity
    - relative to a modeling paradigm that can be used for prediction
      - For example, F=ma implies mass (m) is constant
  - Life cycle dependency
    - As: required, proposed, built, maintained, operated…
  - Need to archive - What, how, who, why, when, ...
- Observation or measurement has method -
  - estimation, analysis, test
- Estimation, analysis, test has -
  - Methodology detail & conditions, measure with units and valu

PDES, Inc.®

On Property Metadata

- Measure with units and value may be -
  - numeric, Boolean, fuzzy, percentile, probabilistic etc.
- Properties have relationships -
  - laws of nature-math-geometry, product design, risk & opportunity, engineering insight, corporate knowledge - these are properties
- Values have measures of precision -
  - statistical, fuzzy, bounded - these are properties
- Methodology detail & conditions defines
  - How, under what conditions - these are properties

H.P. Frisch
21-Jan-00

PDES, Inc.®

AP233 Current Focus/Capability

- System architecture information model
  - Functional hierarchy
  - Physical architecture
  - Allocations
- System modeling
  - Finite State Machines, causal chains, statecharts, …
  - EXCEL spread sheets (e.g. GSFC/JPL's IMDC, Team_X, ISAL, Team_I)
- Verification & Validation
- Requirements Capture, Decomposition & Tracking
- PDM, CM, Work Flow, Graphics, …
- Current work is essential, it appears solid

PDES, Inc.®

AP233 Status

- Requirements document ready for final approval by AP233 working group in Melbourne (2/00)
  - NASA/PDES needs embedded in requirements document
- EXPRESS & EXPRESS-G models exist, definitions for entities, attributes - some written, more in Melbourne
- NASA need issues being pushed hard; but, consensus required
  - SE to EA information exchange interface
  - Technical Data Packages (TDP) (AP232 has enabling capability)
  - Embedded within TDP's is property metadata
- EXPRESS expert from NASA/PDES need group required
  - Evaluate EXPRESS model and validate that needs are being satisfied
  - Support modularization & harmonization

PDES, Inc.®

AP233 Requirements Document Requirements Breakdown

- System & system view
- Requirements
  - Representation of requirement
  - Requirements structure
  - Relations between requirements and other artifacts
- System behaviour and functional architecture
  - Representation of system behaviour and functional architecture
  - Relations of system behaviour and functional architecture to artifacts
- System physical architecture and interface control

Artifact - any object made by human work

PDES, Inc.®

AP233 Requirements Document Requirements Breakdown (con't)

- System properties, classification and data definition
  - System properties definition
  - Relations between system properties and other artifacts
- System engineering data management
  - Document management
  - Artifact management
  - Project management
  - Engineering workflow
  - Administration
- Model layout and presentation information

PDES, Inc.®

Backup & Miscellaneous

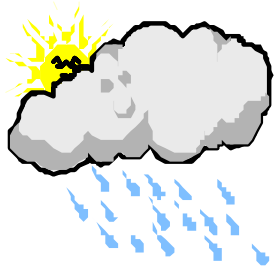
H.P. Frisch
21-Jan-00

PDES, Inc

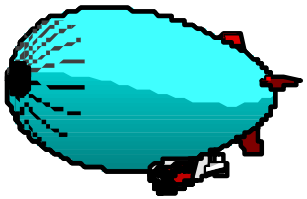
Properties

The properties of a product are dependent on its environment.

Environment



Product



Properties

Temperature,
Pressure
Wind Velocities

Shape, Size,
Temperature
Speed, Fuel
Consumption

PDES, Inc.®

AP233 NASA Needs

- AP 233 information model needed to support:
  - Requirements definition, requirements traceability and verification
  - Define and allocate performance budgets
  - Identify and perform mission and technical trades
  - Perform risk analyses
  - Perform cost trades
  - Perform system optimization

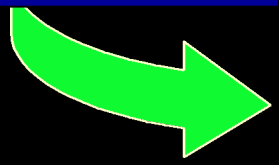
PDES, Inc.®

SITUATION

The innovative solution is a mix of

- Mechanical design (overall shape)
- Flight dynamics rules
- Electronics design
- Computer science
- Human science
- Pyrotechnics…

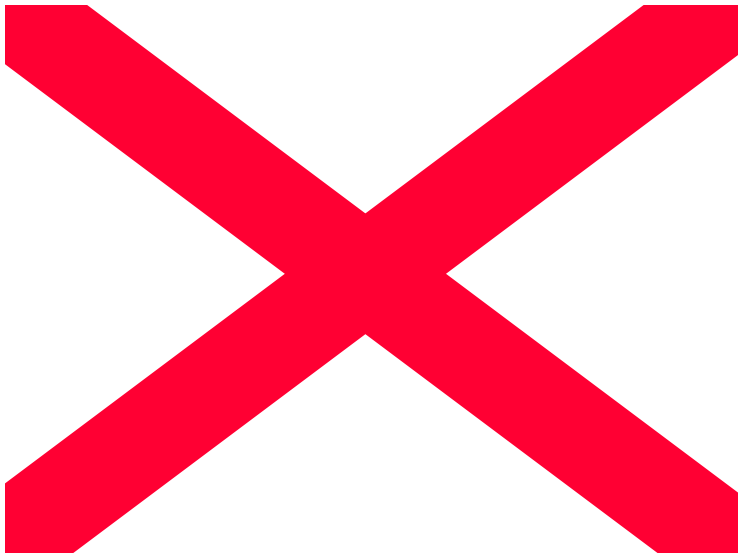
+ Existing system designs



The problem for the system provider

- Have several teams work all together
- Have one consistent system repository
- Deal with several design tools
- Ensure design quality

Slide from SEDRES team



Slide from STEP Frameworks document

PDES, Inc.®

SITUATION

Several disciplines

Several teams
Internal
External

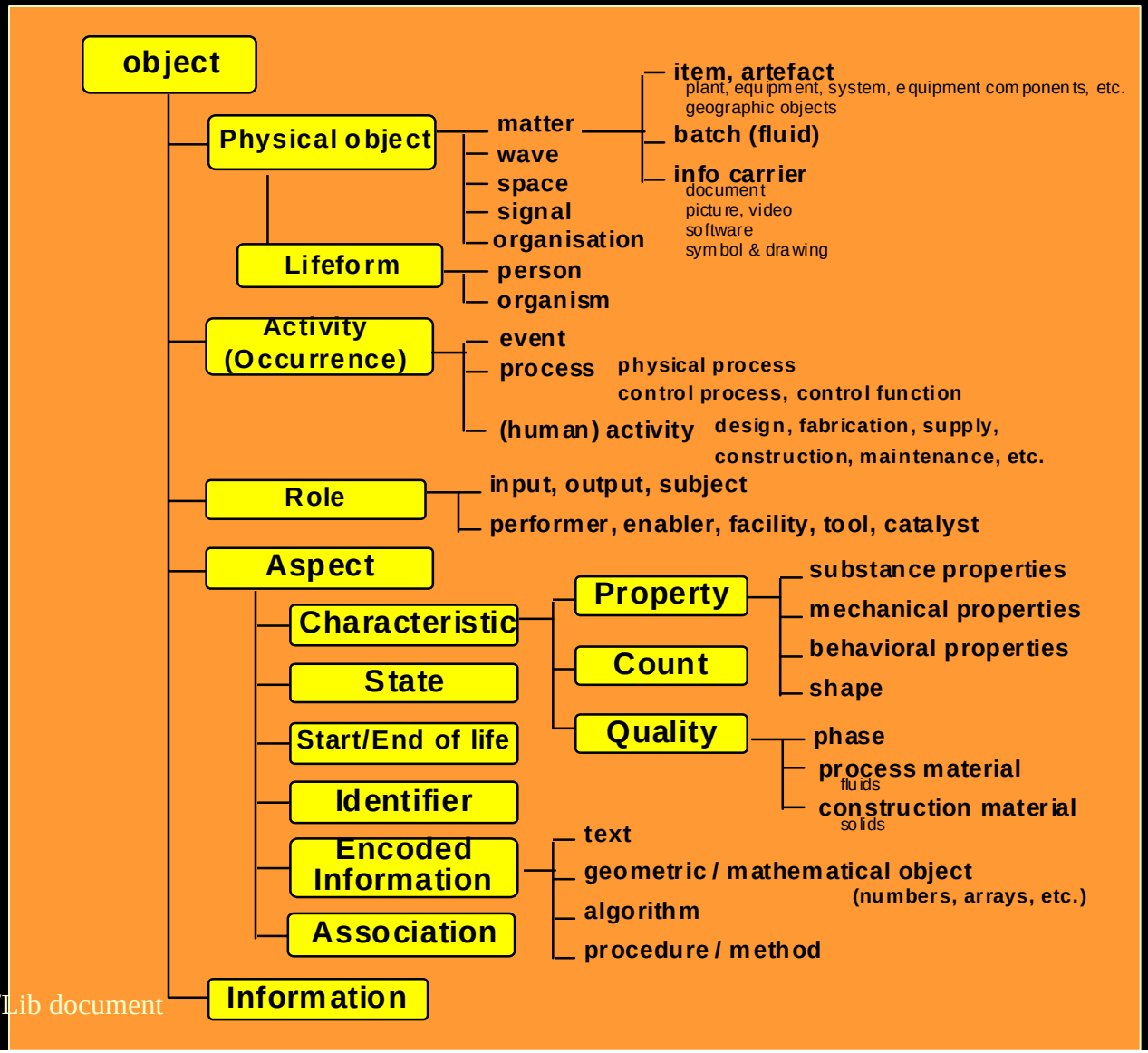
Several tools
Domain
Culture

Quality
Data consistency
Process improvement
System data management

Slide from SEDRES team

PDES, Inc.®

Structure of STEPlib Library

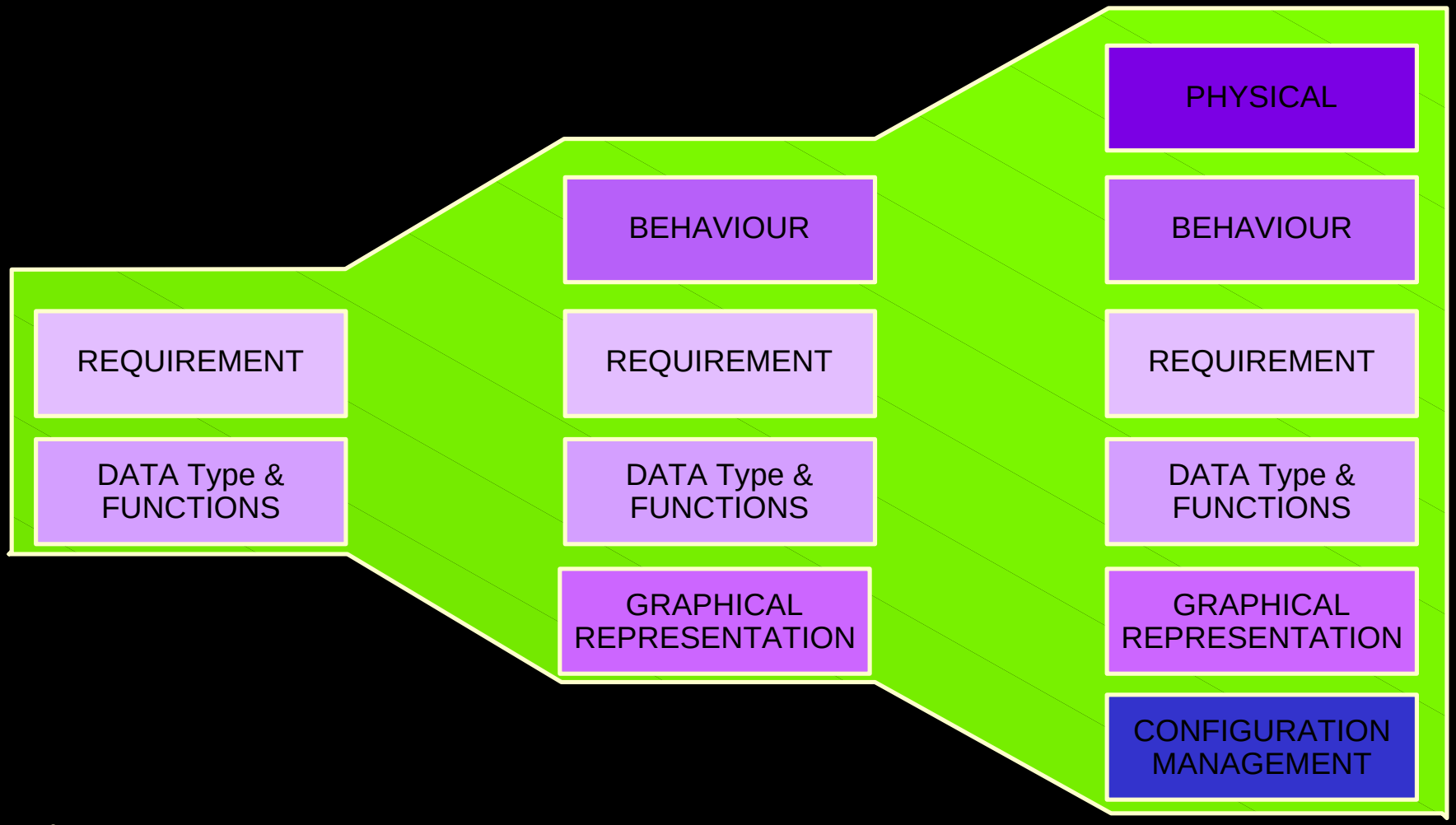


Slide from STEP/Lib document

H.P. Frisch
21-Jan-00

PDES, Inc.®

SEDRES APPROACH TO CURRENT DATA MODEL



Slide from SEDRES team